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DESCRIPTION

TRANSPORTATION SYSTEM

TECHNICAL FIELD

The present invention relates a transportation system for passengers or cargos, and particularly a monorail system where a small-sized, light-weighted vehicle can be used.

BACKGROUND ART

In the past, monorail has been widely used as a transportation system connecting between two sites spaced by a short to middle distance (for example, 5 to 20 km) such as between residential and industrial districts or between downtown and airport. In the monorail, since a rail is supported by bridge piers constructed on the ground at a required interval, there are advantages that the degree of freedom of design of transportation route is high, and the construction cost can be saved due to a reduced land area for construction, as compared with the case of laying rails for a regular railway.

On the other hand, a large drive unit is usually needed to accelerate a vehicle from a stopped condition to a required speed. When such a large drive unit is mounted in the vehicle, it leads to increases in size and weight of the vehicle. Consequently, huge bridge piers are needed to support the rail and the vehicle. This becomes a cause of lowering the degree of freedom of design with respect to the construction of a monorail system. Furthermore, as larger the land area needed to construct the monorail system, the construction cost also becomes higher. Thus, the conventional transportation system such as monorail still has plenty of room for improvement.

SUMMARY OF THE INVENTION

In view of the above-described problems, a primary concern of the present invention is to provide a transportation system having an advantage that a small-sized, light-weighted drive unit can be used as the drive unit

mounted on a vehicle to achieve reductions in size and weight of the vehicle, thereby saving the cost for constructing the transportation system, and increasing the degree of freedom of design.

That is, the transportation system of the present invention for allowing the vehicle to run between stations on a track is characterized by comprising an acceleration zone for accelerating the vehicle by a propulsion supply unit provided in the vicinity of the station, and an autonomous traveling zone for allowing the vehicle accelerated in the acceleration zone to travel on the track in an autonomous manner without the propulsion supply unit.

According to the above transportation system of the present invention, since the vehicle is accelerated by the propulsion supply unit provided in the vicinity of the station, it does not need to carry a large drive unit having the capability of providing a large propulsion force to accelerate the vehicle from a stopped condition to a required speed. Consequently, remarkable reductions in size and weight of the vehicle can be achieved. Therefore, even when a sufficient land area for constructing huge bridge piers for a conventional vehicle carrying the large drive unit thereon is not secured, the transportation system of the present invention can be actualized by constructing relatively small bridges piers for the small-sized, light-weighted vehicle. Thus, the present invention provides an increased degree of freedom of design with respect to the construction of the transportation system. Furthermore, impossible to overlook is a considerable reduction in the construction cost.

In the present invention, it is preferred that the propulsion supply unit of the transportation system is a linear-type accelerator for accelerating the vehicle by providing a propulsion force from a first magnet located on the track to a second magnet mounted on the vehicle. In this case, it is possible to smoothly accelerate the vehicle from the stopped condition to the required speed through a relatively short distance, and therefore give a comfortable ride quality to the passengers.

In addition, it is preferred that the propulsion supply unit is the coaster-type accelerator comprising an auxiliary track formed at an uphill gradient in the vicinity of the station, and a lifter for lifting the vehicle on the auxiliary track, which is provided such that when the vehicle lifted on the auxiliary track is released, it is accelerated by gravitation. In particular, when the propulsion supply unit provided in the vicinity of one of the stations is the linear-type accelerator described above, and the propulsion supply unit provided in the vicinity of the other station is the coaster-type accelerator described above, the passengers are allowed to enjoy a moderate entertainment provided by different accelerating methods in approach and backhaul routes between the stations. Therefore, this transportation system is particularly suitable to transfer the passengers in amusement parks and theme parks.

As a particularly preferred embodiment of the present invention, the transportation system has a rail extending between stations and a vehicle movable on the rail and carrying a drive unit, and is characterized by comprising a first zone for accelerating the vehicle from a stopped condition to a required speed by a propulsion force supplied from the propulsion supply unit provided from one of the stations toward the other station by a predetermined distance, and a second zone not having the propulsion supply unit, in which the vehicle accelerated in the first zone travels on the rail by the propulsion force supplied from the drive unit.

In the above-described transportation system, it is particularly preferred that the propulsion supply unit is the linear-type accelerator for accelerating the vehicle by the propulsion force supplied from a fixed magnet located along the rail to a movable magnet mounted on the vehicle, and the drive means comprises a wheel driven by a motor mounted on the vehicle, and an auxiliary rail formed in the second zone in parallel with the rail such that the wheel travels thereon.

Additional features and advantages of the present invention will be

more clearly understood from the best mode for carrying out the invention described below.

BRIEF EXPLANATION OF THE DRAWINGS

FIG. 1 is a schematic diagram of a monorail system according to a first embodiment of the present invention;

FIG. 2 is a front view of the monorail system;

FIG. 3 is a side view of a vehicle used in the monorail system;

FIG. 4 is a cross-sectional view of a first zone of the monorail system;

FIG. 5 is a cross-sectional view of a second zone of the monorail system;

FIG. 6 is a partially side view of the vehicle traveling in the second zone;

FIG. 7 is a cross-sectional view of a braking device of the monorail system;

FIG. 8 is a schematic diagram of a monorail system according to a second embodiment of the present invention;

FIG. 9 is a partially enlarged view of the monorail system of FIG. 8;

FIG. 10 is a schematic diagram of a monorail system according to a modification of the second embodiment;

FIG. 11 is a schematic diagram of a seat posture controller provided in the vehicle;

FIG. 12 is a schematic diagram of a backrest adjuster provided in the vehicle; and

FIG. 13 is a front view of the monorail system of the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

A transportation system of the present invention is explained in detail according to preferred embodiments, referring to the attached drawings.

(FIRST EMBODIMENT)

As a preferred embodiment of the transportation system of the present invention, a monorail system is explained. In this monorail system, as shown in FIGS. 1 to 3, a vehicle **3** is allowed to run between stations **2** on a rail **1** as a single track supported by bridge piers **4**. In a first zone **A**, the vehicle **3** is

accelerated from a stopped condition to a required speed by a propulsion force supplied from a propulsion supply unit, which is located from one of the stations toward the other station by a predetermined distance. In a second zone **B**, the vehicle **3** travels by use of a drive unit mounted thereon.

In the present embodiment, a liner-type accelerator is used as the propulsion supply unit disposed in the first zone **A**. That is, the rail **1** extends horizontally in the first zone **A**, and a fixed magnet **13** is disposed along the rail **1**. The fixed magnet **13** gives the propulsion force to a movable magnet **34** mounted on the vehicle **3** to accelerate the vehicle **3**, as shown in FIG. 4.

In FIG. 4, the rail **1** is mainly composed of a main girder **10**, pair of round pipe rails **11** made of a steel and disposed at upper right and left sides of the main girder **10**, and a coupling member **9** for coupling between the main girder **10** and these pipe rails **11**. The vehicle **3** has upper wheels **30**, side wheels **31** and lower wheels **32**, which respectively contact the pipe rails **11** from the upper, side and lower directions to be rotatable on the pipe rails **11**. The upper wheels **30** are main wheels for supporting the weight of the vehicle **3**. The side wheels **31** are side guide wheels. The lower wheels **32** are lift-off preventing wheels. Thus, since each of the pipe rails **11** is caught by the upper, side and lower wheels (**30**, **31**, **32**), it is possible to prevent derailment of the vehicle **3** at steep slope and sharp curve locations, and ensure the safety of the transportation system. The upper, side and lower wheels (**30**, **31**, **32**) may be made of an elastic material such as urethane. In this case, a comfortable ride quality can be achieved by preventing vibrations of the vehicle **3** traveling on the rail **1**. In addition, it is effective to prevent noise pollution.

As shown in FIG. 5, the vehicle **3** has the drive unit for allowing the vehicle to travel in an autonomous manner. This drive unit is composed of a small-sized motor **36** driven by electric power, drive wheel **35** rotated by the motor **36**, and a hoisting mechanism for moving the drive wheel **35** up and down. As shown in FIG. 6, the hoisting mechanism comprises an arm **37**, and

an actuator **38** such as an air cylinder and a hydraulic cylinder used to pivot the arm **37** about a shaft **39**. The small-sized motor **36** and the drive wheel **35** are supported by the arm **37**. In this case, when the drive wheel **35** is moved down by the hoisting mechanism, it contacts an upper surface of an auxiliary rail **14** provided on the top surface of the coupling member **9**, so that the vehicle **3** can travel on the auxiliary rail **14** by driving the small-sized motor **36** to rotate the drive wheel **35**. This drive unit may be formed such that after the vehicle **3** accelerated to the required speed in the first zone **A** comes in the second zone **B** and travels on the rail **1** by inertia, autonomous traveling of the vehicle **3** is actualized by contact of the drive wheel **35** with the auxiliary wheel **14** when the traveling speed becomes lower than a predetermined value.

In FIG. 6, the numeral **50** designates a speed detector. The traveling speed of the vehicle **3** can be detected by a pulse signal detector or an encoder of the speed detector **50**. When the traveling speed becomes lower than the predetermined value, a valve **51** is switched, so that the drive wheel **35** is moved down from a lifting (lift-off) position by the actuator **38** to press the drive wheel **35** against the auxiliary rail **14**. Consequently, the vehicle **3** can travel on the rail **1** by a running torque of the small-sized motor **36**. On the contrary, when the traveling speed of the vehicle **3** is equal to or more than the predetermined value, the drive wheel **35** is left from the auxiliary rail **14** by the actuator **38**, so that the vehicle **3** travels on the rail **1** by inertia force. Thus, according to the propulsion force supplied in the first zone **A**, the vehicle **3** can travel by inertia. Alternatively, according to the propulsion force obtained in a downslope region, the vehicle **3** can travel by inertia. Therefore, it is possible to save electric power consumption needed to operate the monorail system.

As a modification of the present embodiment, when accelerating the vehicle **3** by using both of the propulsion force supplied in the first zone **A** by the linear-type accelerator and the propulsion force supplied by the drive unit, it is possible to decrease the length of the first zone **A**. In addition, since the

liner-type accelerator formed along the rail **1** can be scaled down, it is possible to further downsize the monorail system.

Thus, it is not necessary for the vehicle **3** to carry a large drive unit having the capability of providing an output power for accelerating the vehicle **3**. In other words, it is good enough to carry a relatively small drive unit having the capability of providing an output power for keeping the traveling speed of the vehicle **3**. Therefore, as compared with a conventional monorail system not having the acceleration zone such as the first zone **A**, a downsized motor can be used as the drive unit mounted on the vehicle in the monorail system of the present invention. As a result, it is possible to achieve remarkable reductions in size and weight of the vehicle.

In FIG. 4, the numeral **17** designates a power supply unit for the vehicle **3**. This power supply unit **17** is provided on the coupling member **9**, and electric power can be supplied to the vehicle through a current collector (not shown) of the vehicle. In addition, when the electric power supply unit **17** is located on the rail **1** in the station area, and a battery (not shown) is mounted on the vehicle **3**, the battery can be charged through the current collector at the stopped condition. For example, an interior light or an air conditioner may be operated by using the electric power supplied from the charged battery.

As shown in FIG. 7, a braking device of the vehicle **3** of the present embodiment comprises a brake plate **60** provided at a lower portion of the vehicle **3**, and a brake unit **15** provided on the top surface of the coupling member **9**. The brake unit **15** has a pair of brake pads **16** for stopping the vehicle **3** by sandwiching the brake plate **60** therebetween. The braking device is not limited to this embodiment. For example, a downsized motor with a brake, or a brake attached to the drive wheel **35** may be used.

In addition, the vehicle **3** has a flat floor designed in a barrier free manner. In this case, it is possible to prevent a situation that the passenger

stumbles in the vehicle, and improve the safety of the monorail system. In addition, since children and elder people can safely ride on the vehicle, there is a further advantage of expanding the age group of passengers using the transportation system.

(SECOND EMBODIMENT)

In the above embodiment, the monorail system having the first zone **A**, in which the linear-type accelerator is provided in the vicinity of the respective station **2**, was explained. As shown in FIG. 8, the monorail system of the present embodiment is substantially the same as that of the first embodiment except that the first zone **A** using the linear-type accelerator is formed in the vicinity of one of the stations **20**, and a third zone **C** using a coaster-type accelerator is formed in the vicinity of the other station **21** as the propulsion supplying unit other than the linear-type accelerator. Therefore, duplicate explanations are omitted.

As shown in FIG. 9, the coaster-type accelerator of this embodiment is mainly composed of an additional rail **100** formed at an uphill gradient in the vicinity of the station, and a lifting device (not shown) fixed at a top end of the additional rail. For example, the lifting device comprises a motor with reduction gears and a chain. Alternatively, the lifting device may be formed with a rope, winding unit, motor with reduction gears, and an elevating table. When the vehicle **3** is lifted up along the additional rail **100** by the lifting device, and then released, it glides on the additional rail **100** toward the station **20**, and then comes in the second zone **B** at a required traveling speed.

According to the monorail system of the present embodiment, the vehicle **3** is allowed to run between the stations (**20**, **21**), as described below. That is, when the vehicle **3** travels from the station **20** toward the station **21**, it is accelerated from a stopped condition at the station **20** to a desired traveling speed by the linear-type accelerator of the first zone **A**. Then, the accelerated vehicle travels in the second zone **B** by use of the drive unit mounted on the

vehicle so as to maintain the traveling speed. Alternatively, when the traveling speed of the accelerated vehicle is equal to or greater than a predetermined value in the second zone **B**, the vehicle **3** may travel by inertia. When the traveling speed becomes smaller than the predetermined value, the vehicle travels by use of the drive unit mounted thereon. As a result, the vehicle **3** arrives at the station **21** through the second zone **B**.

On the other hand, when the vehicle **3** travels from the station **21** toward the station **20**, the vehicle **3** is lifted up along the additional rail **100** in the third zone **C**. When the vehicle reaches a required height, it is released from the lifting device, so that the vehicle **3** glides down the additional rail **100**. In other words, the vehicle is accelerated to the required speed by gravitation and then comes in the second zone **B**. The accelerated vehicle travels in the second zone **B** in the same manner as the case of allowing the vehicle **3** to travel from the station **20** to the station **21**. Consequently, the vehicle arrives at the station **20** through the second zone **B**. At this time, the first zone **A** functions as an extension of the second zone **B** rather than the acceleration zone. As shown in FIG. 9, the downside space of the additional rail **100** in the third zone **C** can be effectively used as a carriageway or a sidewalk.

Thus, when using different accelerating methods in approach and backhaul routes between the stations (**20**, **21**), the passengers of the vehicle can enjoy a moderate entertainment. Therefore, this transportation system is preferable to transport the passengers to an amusement park, or between attractions in the amusement park.

As a modification of the present embodiment, as shown in FIG. 10, the third zone **C** of coaster-type accelerator may be formed at the vicinity of the station **20** in place of the first zone **A** of the linear-type accelerator.

By the way, when using the coaster-type accelerator to accelerate the vehicle, the vehicle **3** is placed on the slope of the additional rail **100**. Therefore, from the viewpoint of achieving a safe and comfortable

transportation of the passengers, it is preferred to use a seat posture controller for stably holding the passengers on seats in the vehicle.

For example, it is preferred to use the seat posture controller shown in FIG. 11. This controller comprises seats (**70**, **71**) pivotally movable in the vehicle, gravity detector **76** for detecting a direction of gravity, and a seat angle adjuster **74** controlled according to an output of the gravity detector **76**. The seat **70** is pivotally supported about a fulcrum **72** at a position higher than a center of gravity of the passenger on the seat, e.g., at substantially a shoulder position of the passenger on the seat **70**. The seat angle adjuster **74** has a fluid power cylinder or a damper, which is disposed in a space between the seat **70** and the vehicle's floor. The center seat **70** is configured in an inverted T-shape, and supported to be pivotally movable against the floor, as shown by the solid and dotted lines in FIG. 11. In addition, one side of the seat **70** is used for the passengers that face toward the traveling direction, and the other side of the seat **70** is used for the passengers that face toward the opposite direction.

According to the posture controller described above, even when the vehicle **3** is placed on the slope of the additional rail **100** in the third zone **C**, the seat surface can be always maintained to be substantially perpendicular to the direction of gravity. Therefore, the seat can stably receive the weight of the passenger to provide a comfortable ride quality to the passenger. This seat posture control unit may be used in the transportation system not having the third zone **C** of the present invention. In place of controlling the seat angle according to the direction of gravity detected by the gravity detector **76**, it is also preferred to control the seat angle by detecting a change of acceleration in the traveling direction (longitudinal direction) of the vehicle **3**, or an inclination in the transverse direction of the vehicle.

In addition, as shown in FIG. 12, it is also preferred that the transportation system of the present invention comprises a position adjuster **80**

of a backrest **75** of the seat. According to this adjuster, it is allowed for the passengers on the seat to face toward the traveling direction. Therefore, even when the vehicle is suddenly accelerated in the traveling direction, the weight of the passenger is stably received by the backrest, so that the passengers can get the comfortable ride quality. In the case of using the seat with the movable backrest **75**, it is also preferred to adopt an automatic adjusting mechanism having the capability of adjusting positions of all of the backrests at a time after all of the passengers get down from the vehicle stopped at the station. According to this mechanism, it is possible to avoid a trouble that the passengers are forced to adjust the positions of the backrests every time of changing the traveling direction, and therefore further improve service to the passengers of the transportation system.

As a further advantage of the present invention, the transportation system is excellent in compatibility with the surrounding environment. For example, as shown in FIG. 2, the rail **1** can be supported by bridge piers **4** having an increased height, which are constructed at a center portion of an existing sidewalk **5**. Alternatively, as shown in FIG. 13, the rail **1** may be supported by another bridge piers **4** having a small height, which are constructed at a center divider between adjacent existing carriageways **6**. Thus, the transportation system of the present invention can be constructed under a high degree of freedom of design.

INDUSTRIAL APPLICABILITY

As described above, the present invention provides a near-future type of transportation system for safely and comfortably transferring passengers with the advantages of pollution-free and energy conservation, and therefore it is hopefully expected as a new traffic system in urban developments actively performed at landfill sites in recent years. In addition, when the transportation system is constructed at an expensive location, the construction cost can be remarkably saved due to a reduced land area for the construction.

Moreover, when the transportation system of the present invention is used to transfer passengers in amusement parks and theme parks, it is possible to provide a moderate entertainment to the passengers by the acceleration zone using the above-described coaster-type accelerator.

Therefore, the present invention is expected to be utilized as the transportation system for connecting between residential and industrial districts or between downtown and airport, which are spaced from each other by a short to middle distance, transportation system for the passengers in the amusement parks and the theme parks, and as the new traffic system in the urban developments for the next generation.